

Effects Framework for OpenGL Testing

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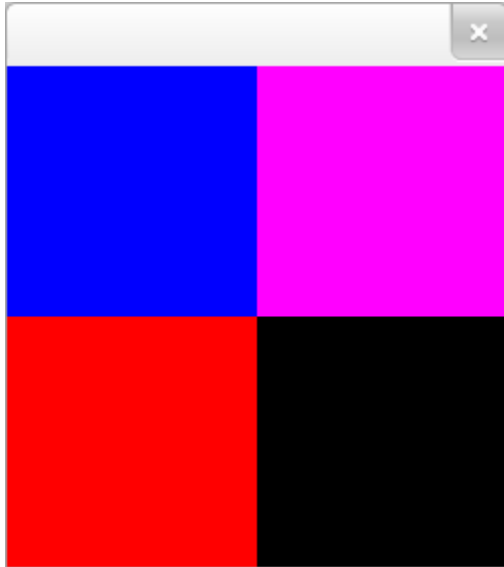


Agenda

- Why?
- What is an “effect” anyway?
- nvFX
- Is nvFS useful?



Why?



Why?

```
uniform mat4x2 arg0;  
uniform mat4x2 arg1;  
uniform float tolerance;  
uniform mat4x2 expected;  
  
void main()  
{  
    mat4x2 result = matrixCompMult(arg0, arg1);  
    mat4x2 residual = result - expected;  
    float error_sq = residual[0][0] * residual[0][0] + residual[0][1]  
        * residual[0][1] + residual[1][0] * residual[1][0] + residual[1][1]  
        * residual[1][1] + residual[2][0] * residual[2][0] + residual[2][1]  
        * residual[2][1] + residual[3][0] * residual[3][0] + residual[3][1]  
        * residual[3][1];  
    gl_FragColor = error_sq <= tolerance * tolerance  
        ? vec4(0.0, 1.0, 0.0, 1.0) : vec4(1.0, 0.0, 0.0, 1.0);  
}
```



Why?

```
#version 130
in vec3 normal_es, position_es;
out vec4 color;
uniform vec3 light_es = vec3(0.0, 15.0, 4.0);
uniform float m = 0.2;
uniform float ri = 1.5;
uniform vec3 color_s = vec3(1.0);
uniform vec3 color_d = vec3(1.0, 0.0, 0.0);

float schlick(float ni, float cos_theta)
{
    float c = 1.0 - cos_theta;
    float r0 = (ni - 1.0) / (ni + 1.0);
    r0 = r0 * r0;
    return r0 + (1.0 - r0) * pow(c, 5.0);
}

float G(float n_dot_l, float n_dot_h,
        float n_dot_v, float v_dot_h)
{
    float c = 2.0 * n_dot_h / v_dot_h;
    return min(1.0, c * min(n_dot_v,
                            n_dot_l));
}
```

```
float beckmann(float m, float cos_theta)
{
    float c2 = cos_theta * cos_theta;
    m = max(m, 1e-6);
    float m_c2 = m * c2;
    return exp((c2 - 1.0) / (m * m_c2))
        / (4.0 * m_c2 * m_c2);
}

void main(void)
{
    vec3 l = normalize(light_es - position_es);
    vec3 v = -normalize(position_es);
    vec3 n = normalize(normal_es);
    vec3 h = normalize(l + v);
    float ndl = dot(n, l);
    float ndh = dot(n, h);
    float ndv = dot(n, v);

    float f = schlick(ri, ndv) * beckmann(m, ndh)
        * G(ndl, ndh, ndv, dot(v, h)) / ndv;

    vec3 spec = f * color_s;
    vec3 diff = color_d * max(ndl, 0.);

    color = vec4((spec + diff), 1.0);
}
```



Why?

- `shader_runner` is piglit's mechanism for testing shaders
 - Really hard to draw anything other than a rectangle
 - Really hard to get additional per-vertex data to the shader
 - Really hard to use a non-trivial texture
 - You can use any texture you want, as long as you only want checkerboard or RGBW
 - Really hard to set other GL state
 - Difficult to extend
 - The parser... gives me nightmares.
 - etc.



Why?

- Holy grail: Easily import shaders from real apps
 - shader_runner doesn't really help here
 - There are a couple shader tests like this
 - apitrace could help
 - Trace files tend to be quite large
 - Trace files are difficult to tweak
 - Want to modify a GL 3.3 test to run on GL ES 3.0
 - Trace files are difficult to create from scratch
 - Write an application, then trace it



What is an effect?

- High-level encapsulation of a drawing method
 - Shader code
 - Uniform values
 - GL state settings
 - Samplers, textures, etc.
 - Rasterization settings
- An effect may contain multiple passes
 - Set one shader & parameters, draw, repeat...



What is nvFX?

- An effects file format created by Tristan Lorch (NVIDIA)
 - Inspired by cgFX, but not specific to cg
 - Open-source library
 - <https://github.com/tlorach/nvFX>
- See also:
 - <https://developer.nvidia.com/sites/default/files/akamai/gamedev/docs/nvFX%20A%20New%20Shader-Effect%20Framework.pdf>
 - Search “nvfx site:developer.nvidia.com”
 - https://www.khronos.org/assets/uploads/developers/library/2013-siggraph-opengl-bof/nvFX-effects-framework-OpenGL-BOF_SIGGRAPH-2013.pdf
 - Search “nvfx site:khronos.org”



nvFX Layout

```
GLSLShader { // Prepend to all shaders
    #version 130
    uniform mat4 mvp;
}
GLSShader ObjectVS {
    in vec4 position;
    in vec3 normal;
    out vec3 normal_eye_space;
    void main() {
        ...
    }
}
GLSLShader ObjectFS {
    ...
}
GLSLShader DiffuseFromTexture {
    uniform sampler2D tex;
    vec4 getDiffuse(vec3 tc) {
        return texture(tex, tc);
    }
}

SamplerState defaultSampState {
    TEXTURE_MIN_FILTER =
        LINEAR_MIPMAP_LINEAR;
    TEXTURE_MAG_FILTER = LINEAR;
}
TextureResource2D diffuseTexture <
    defaultFile = "image.ktx";
> {
    SamplerState = defaultSampState;
}

Technique TECH_Diffuse {
    Pass p0 {
        VertexProgram = ObjectVS;
        FragmentProgram = { ObjectFS,
            DiffuseFromTexture };
        SamplerResource(tex) =
            diffuseTexture;
    }
}
```



nvFX Layout

```
namespace floor {  
    GLShader VS {  
        ...  
    }  
    ...  
}
```

```
Technique TECH_Floor {  
    Pass p0 {  
        VertexProgram = floor::VS;  
        FragmentProgram = floor::FS;  
    }  
}
```



Mixed Versions

```
GLSLShader common_gl {  
    #version 130  
}  
GLSLShader common_gles {  
    #version 300 es  
}  
  
GLSLShader foo {  
    ...  
}
```

```
// C++ code has to read the  
// annotation and do something smart  
// with it.  
Technique TECH_gl <  
    GLSL_min_version = 1.30  
> {  
    VertexProgram = { common_gl,  
                     foo };  
  
    ...  
}  
Technique TECH_gles <  
    GLSL_min_version = 3.00  
> {  
    VertexProgram = { common_gles,  
                     foo };  
  
    ...  
}
```



nvFX Advantages

- More robust language for combining shaders into programs
- More robust language for changing GL state
- Much better mechanism for associating data with vertex attributes
- Multiple passes
- Non-screen render targets
 - So that effects can render shadow maps, etc.
- Shaders targeting multiple shading languages can live in one place
 - Sharing shader text across versions is clunky
- Documentation :)



nvFX Disadvantages

- Still requires a lot of C++ code to use
- No direct integration with models
 - Model files would generally reference effects (by name) that are defined in the fx files
 - Sort of the opposite binding order from what we want
- No transform feedback support
- No direct way to verify results of rendered image
- No way to specify effect requirements
 - Like “GLSL $\geq$ 1.30” in `shader_runner`
 - Annotations may fill this gap
- No Linux or Mac build targets yet
 - It uses cmake, so it shouldn't be too hard to add...



Can piglit use nvFX?

- Probably not as-is
 - Not straightforward to replace tests that draw many quads & probe results
 - No obvious way to supply additional vertex data
 - Standard set of model files?
 - We'd probably have to extend their parser
- If apitrace could generate nvFX files...



Can shader_runner borrow ideas from nvFX?

- Nice file format
 - Decent parser, too
 - Clean syntax for textures and state information

```
[require]
GL >= 3.0
```

```
[fx]
...
```

```
[test]
technique foo
draw rect -1 -1 1 1
probe rgb 10 10 0 1 0
...
```

- May provide an eventual migration path to nvFX



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